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Assessment of the Effects of Chemical and Cultural Control on Incidence of Leaf Blast (Magnaphorthe grisea), Growth and ield Loss of Foxtail Millet (Setaria italica (L.) P.BEAUV) in Northeastern Nigeria

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Abstract
In 2007 cropping season, a multilocational trial was laid in split-plot using a randomized complete block design at the Teaching and Research Farm of the Faculty of Agriculture, University of Maiduguri and Gashua Farm Station lying in the Sudan and Sahel agro-ecological zones resepectively. The aim was to assess the effects of chemical and cultural (seed rates) control on the incidence of leaf blast (*Magnaphorthe grisea*), growth and yield loss of foxtail millet in the Northeastern Nigeria. The results of 2007 showed that plants grown from the highest fungicide seed treatment level of 100% had significantly ($P \leq 0.5$) the lowest disease incidence of 20.8% and, 0.4% while the untreated chech recorded significantly ($P \geq 0.5$) the highest disease incidence of 80.0% and 64.3% at Maiduguri and Gashua agro-ecological locations respectively. Results showed that at Maiduguri and Gashua locations, plant grown from seed rate of 12.5kg/ha had significantly ($P \geq 0.05$) the highest disease incidence of 51.6% and 39.7% respectively. According to the results, the effects of the fungicide seed treatment levels and seed rates on plant height and panicle length of foxtail millet were highly significant ($P \geq 0.05$) but the heading days was not significant ($P \leq 0.05$) at both locations. Higher plant height and panicle length were recorded at fungicide seed treatment ranging from 80 – 100% and seed rate of 5.0kg/ha. Also, the highest grain yields were obtained at the fungicide seed treatment level of 80 to 100% and at seed rate of 10kg/ha at the two locations. Results showed that the lowest plant height and panicle length were recorded on plants grown from the untreated seeds (control) at the highest seed rate of 12.5kg/ha while the lowest grain yield was recorded from the untreated plants at the lowest seed rate of 5.0kg/ha at Maiduguri and Gashua locations respectively. The results therefore provide a vital idea to the farms on how to manage crop diseases and optimize grain yield.
Keywords: Incidence, Fungicide, Disease seed rate, Seed treatment, cultivar

INTRODUCTION

Foxtail Millet (*Setaria italica* (L.) p. BEAUV) is the second most widely cultivated species of millet in the world (Zohary and Hopf, 2000). Millet is a very important food grains and economic crop in areas where it is cultivated extensively. It is known by several other names such as Italian millet, German millet, Chinese millet and Hungarian millet (Baker, 2003). The crop is a dwarf millet cultivar newly introduced in Bauchi State and other northern Nigerian Savannah where several millet cultivars are as food and cash crop. According to Nkama *et al.* (1994), most of the millet grains produced in Nigeria are used for human consumption and for preparing fermented and unfermented breads, weaning food and for production of local alcoholic beverages (Nkama, 1998) Millet generally can adopt to poor nutrient sandy soil in low rainfall areas and it is one of the oldest cultivated crop in sub-Saharan west African (D Andrea *et al.,* 2001)

In Nigerian savannah where several millet cultivars are grown extensively, plant disease pose a big threat in lowering the yield potential if necessary and adequate disease control measures are not adopted. Leaf blast of foxtail millet is a seed borne fungal pathogen of major economic importance and other prominent fungal diseases includes Smut (*Ustilago crameri*), green ear (*Sclerospora graminicola*) and blight (*Cochliobolus setariae*) ito et kuribayashi) *Drechsler exDastar* (Skerman and Riveros, 1990). According to Kato *et al*. (2001) and Farman, (2002) Leaf blast of foxtail millet has been reported to affect photosynthetic activity and transport of metabolites in the crop. Also Thakur *et al. (2000),* stated that the incidence of the disease has been quite variable depending on cultivars, season and location. Disease can cause an annual yield lose of 6-8% and up to 55% yield loss has been recorded in some millet field in Nigeria (Ajayi *et al*., 1997) Machenzie and Sah (1991) stressed the need for quantitative relationship that relate to the effects of disease and yield losses for development of disease control strategies and crop management plans. Anaso (1996) has pointed out the simulation of various disease conditions which offered a range of data points to predict yield loss in foxtail millet.

The use of chemical and cultural control in combination can effectively lower the disease incidence and severity when ever resistant cultivars are not available even though the use of resistant cultivars has been recommended as the best disease control option, but the genetic improvement is very tedious, slow and takes several years before improved cultivars are introduced for cultivation Richard *et al.* (2008). Similarly, Richard *et* *al.* (2009) reported that seed dressing with Apron star 42WS fungicide control the early stage of anthracnose and ensure high seedling establishment. Also, Anaso (1989) controlled sorghum downy mildew in Maize by seed dressing with Apron plus 35DS. As a Newly introduced crop in the Nigerian Semi-arid regions there is dearth of information on the crop, diseases and environmental factors. Therefore, the objective of this work was to assess the effects of chemical and cultural control on disease incidence growth and yield loss on foxtail millet due to leaf blast (*Setaria italica*) in the Northeastern Nigeria.

MATERIALS AND METHODS

The field experiments were carried out as multi-trials during the 2007 croppings at Maiduguri and Gashua located in the Sudan and Sahel agro-ecological zones respectively. The trail was laid out in a split-plot using randomized complete block design. The varying percentages planting rows of 0%, 20%, 40%, 60%, 80% and 100% sown with Apron Star 42WS treated seeds (2.0g a.i/kg) was laid in the main-plot in order to simulate variable disease incidences, while the variable seed rates of 5.0, 7.5, 10.0 and 12.5 kg/ha was laid in the sub-plots of 5 x 3m replicated four times. There was 0.5m and 1m as spacings between plots and replicates respectively. There was 30cm and 45cm inter- and intra-spacings between plant stands and rows accordingly. An infector rows sown to LCIC 9702 at 4.5m apart was established three weeks earlier. The total land area used was 34.5 x 17m.

The first weeding was done at two weeks after sowing (WAS) and the millet were thinned down to two plants per stand. Inorganic fertilizer was applied at the recommended rate of 60.0kg N/ha, 30kg P2O/ha and 30kg K2O/ha for millet in the savannah according to Anon (1989). The experimental plots were kept weed-free throughout the experimental period.

Data Collection

The leaf blast incidence was recorded at fifty days after sowing of physiological stage.

$$\text{Disease incidence (\%)} = \frac{\text{Number of plants infected by leaf blast in the middle rows}}{\text{Total Number of plants infected and uninfected by the leaf blast in the middle rows}} \times 100$$

The plant heading was taken at fifty-nine days after sowing and while the plant height panicle lengths were recorded at full physiological maturity stage.

Yield

The panicles in the middle rows of each plots were cut-off from the main stalk, sundried properly, threshed, winnowed and the grains were weighed separately and converted in kilogram per hectare. All data were subjected into statistical analysis of variance (ANOVA), the means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Results in (Table 1) showed that in 2007 cropping season, the effect of fungicide seed treatment levels and seed rates on diseases incidence and grain yield were significant in both Maiduguri and Gashua agroecological locations. Results revealed that plants grown from the untreated seed (control) significantly had the highest leaf blast incidence of 80.0% and 64.3% while those grown from the highest fungicide level of 100% recorded the lowest disease incidence of 20.8% and 10.4% at Maiduguri and Gashua respectively (Table 1). Similarly, the effect of different seed rates on disease incidence showed that plants grown from the highest seed rate of 12.5kg/ha recorded significantly the highest disease incidence of 51.6% and 39.7% at Maiduguri and Gashua, while the lowest leaf blast incidence of 41.0% and 28.2% were obtained from the plants grown from the lowest seed rate of 5.0kg/hg at the first and second location respectively.

Table 1: Effect of Fungicide Seed Treatment and Seed Rates on Leaf Blast Incidence of Foxtail millet at Maiduguri and Gashua locations during the 2007 cropping season.

Treatments	Disease Incidence	
	Maiduguri	**Gashua**
Fungicide rates (%)	Leaf blast (%)	Leaf blast (%)
0	80.0a	64.3a
20	60.3b	49.6b
40	50.2c	36.1c
60	39.1d	26.4d
80	27.7e	18.2e
100	20.8f	10.4f
SE ±	1.07	1.10
Seed Rates (kg/ha)		
5.0	41.0d	28.2d
7.5	44.7c	32.5c
10.0	48.1b	36.1b
12.5	51.6a	39.7a
SE ±	0.61	0.65
Interaction		
F x Sr	**	*

Means in the same column followed by similar letter (s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT).

The results in (Table 2) showed that the effect of fungicide levels and seed rates on plant height and panicle length of foxtail millet were highly significant at Maiduguri and Gashua agro-ecological locations in 2007 cropping season, but the heading days was not significantly different at both locations in the same season. The results of 2007 indicated that the highest plant height and panicle length of 44.9cm and 6.2cm; 42.9cm and 6.1cm which were not significantly different from each other was recorded the highest fungicide level of 100% and 80% respectively at Maiduguri. Similarly, the highest plant height of 45.0cm and panicle length of 7.2cm were recorded from foxtail millet grown from seed treated with the highest level 100% fungicide at Gashua. The untreated (0%) plant had the lowest plant height and panicle length of 27.8cm and 4.9cm; 34.3cm and 5.4cm at both Maiduguri and Gashua locations respectively. Also, results in Table 2 showed that at the two locations, plants grown from the lowest seed rate of 5.0kg/ha significantly had the highest plant height and panicle length. Based on this rate, the highest plant height and panicle length of 42.6cm and 6.1cm were recorded at Maiduguri agroecological location, while the highest plant height and panicle length of 44.7cm and 6.5cm were obtained at Gashua agroecological location accordingly. This was followed by the plants grown at the seed rate of 7.5kg/ha.

Results on grain yield in 2007 (Table 2) showed highly significant differences in relation to levels of fungicide seed treatment and seed rates in the two locations. At Maiduguri location, the results revealed that the highest grain yield of 1334.0kg/ha and 1337.0 kg/ha were recorded on plants grown at 100% fungicide level and seed rate of 10.0kg/ha respectively. Also results showed that at Gashua location, the highest grain yield of 1248.0 kg/ha and 981.0 kg/ha were obtained on plants grown from fungicide seed treatment level and seed rate similar to those of Maiduguri. On the same trend, results in (Table 2) also indicates that at Maiduguri location, higher grain yield of 1236.0 kg/ha was recorded on plants grown from 80% fungicide seed treatment level which was not significantly different from the grain yields obtained at 100% fungicide seed treatment level at both locations. The lowest grain yields of 307.0 kg/ha and 264.0 kg/ha were recorded from the untreated plants (%) at Maiduguri and Gashua locations respectively (Table 2) in 2007. Also, the results of the same year showed that the lowest grain yields of 430.0 kg/ha and 414.0 kg/ha were obtained from the plants grown from the lowest seed rate of 5.0 kg/ha at Maiduguri and Gashua zones accordingly.

Table 2: Effects of fungicide seed treatment levels and seed rates on heading, plant height and panicle length of foxtail millet at Maiduguri and Gashua during the 2007 cropping season.

Treatments	Maiduguri Heading (days)	Plant height (cm)	Panicle length (cm)	Grain yield (kg/ha)	Gashua Heading (days)	Plant height (cm)	Panicle length (cm)	Grain yield (kg/ha)
Fungicide rate (%)								
0	57.2	27.8d	4.9e	307d	57.1	34.3e	5.4c	264e
20	57.3	32.2c	5.4d	734c	56.8	36.2d	5.8c	590d
40	27.8	36.2b	5.7c	820c	57.1	37.8cd	5.8c	614d
60	57.7	38.5b	5.8b	980b	57.5	38.7c	6.1c	780c
80	58.3	42.9a	6.1a	1236a	57.3	41.2b	6.4b	1065b
100	58.2	44.9a	6.2a	1334a	57.7	45.0a	7.2a	1248a
SE ±	0.59	0.92	0.04	47.4	0.29	0.61	0.26	43.4
Seed Rate (kg/ha)								
5.0	58.6	42.6a	6.1a	430d	57.3	44.7a	6.5a	414d
7.5	57.8	37.7b	5.9b	867c	57.3	38.9b	6.2a	760c
10.0	57.3	36.3b	5.6c	1337a	57.3	38.1b	6.1b	981a
12.5	57.3	31.7c	5.2d	973b	57.1	33.6c	5.6b	886b
SE ±	0.44	0.63	0.03	30.2	0.21	0.53	0.18	29.7
Interaction								
F x Sr	NS	*	**	**	NS	*	*	**

Means in the same column followed by similar letter(s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT)

Results in (Tables 3) showed that the effects of interaction between the seed treatment fungicide levels and seed rates on the incidence of leaf blast and grain yield were significantly different at both Maiduguri and Gashua locations during 2007. Results obtained from the Maiduguri location proved that plants grown from the untreated seeds at the seed rate of 12.5kg/ha significantly had the highest disease incidence of 90.5 while those plants treated with 100% fungicide at seed rate of 5.0 kg/ha recorded the lowest leaf blast incidence of 13.0% in the same season (Table 3).similarly, results in (Table 3) showed that the highest disease incidence of 74.1% was recorded on the untreated plant (0%) under the seed rate of 12.5kg/ha while the lowest disease incidence of 5.6% was obtained on plants grown from 100% level of fungicide seed treatment under the lowest seed rate of 5.0 kg/ha at Gashua location. Higher grain yields (Table 3) of 1805.0 kg/ha, 1812 kg/ha and 1636 kg/ha which were not significantly different from each other were obtained under the same seed rate of 10.0 kg/ha at fungicide seed treatment levels of 100%, 80% and 60% respectively, while the lowest grain yield of 176.0 kg/ha was recorded from the untreated plant under seed rate of 5.0 kg/ha at Maiduguri location. In contrary, at Gashua location, the highest grain yield of 1599 kg/ha and 1460 kg/ha; 1444 kg/ha and 1326 kg/ha were obtained at fungicide levels 100% and 80%; and at seed rates of 10.0 kg/ha and 12.0 kg/ha respectively.

Table 3: Effect of Interaction between Fungicide seed treatment levels and seed rates on leaf blast incidence and grain yield of foxtail millet at Maiduguri and Gashua locations during the 2007 cropping season.

Fungicide Rate (%)	Maiduguri 5.0	7.5	10.0	12.5	Gashua 5.0	7.5	10.0	12.5
	Seed Rates (kg/ha)							
	INCIDENCE OF BLAST (%)							
0	72.5c	75.7c	81.3b	90.5a	57.9d	59.8c	68.2b	74.1a
20	56.4ef	60.0de	62.3d	62.4d	46.0f	49.2ef	50.7de	52.4de
40	46.7hi	49.8hi	50.5gh	53.7fg	28.9ij	36.4gh	38.5gh	40.7g
60	33.9kl	35.5k	41.8j	56.3ij	19.9kl	24.3jk	27.7j	33.6hi
80	23.6mn	29.9mn	29.4lm	30.8klm	13.8m	14.7m	19.7l	24.5jkl
100	13.0p	20.30o	23.1bo	26.8no	5.6n	10.8m	12.0m	13.1m
SE ±				1.48				
	Grain Yield (kg/ha)							
0	176m	266lm	433kl	355lm	199k	290jk	327jk	241k
20	302lm	733ij	1065efg	837hij	375jk	494hij	778d-g	712efg
40	321lm	794hij	1271cde	893ghi	398jk	606ghi	800d-g	652fgh
60	418kl	856g-j	1636ab	1010fgh	415ijk	841c-f	941cd	924cde
80	631jk	1190def	1812a	1312cd	468hij	1022c	1444ab	132b
100	730ij	1366cd	1805a	1434bc	626f-i	1309b	1599a	1460ab
SE ±					74.02			

Means in the same column followed by letter(s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT)

The results (Table 4) of the combine analysis of the two agroecological locations in 2007 showed that the average (mean) and ranges of heading days, plant height and panicle length are 57.5 (56.5 – 59.5 days), 38.0cm (25.2 – 53.5cm) and 5.9cm (4.2 – 7.5) respectively. On the same trend, results also revealed that the average (mean) and ranges of leaf blast incidence and yield are 40.2% (5.6 – 90.5) and 831.0 kg/ha (176 – 1812 kg/ha) (Table 4).

Table 4: Combine analysis of the effects of fungicide levels and seed rates on heading days, plant height, plant length, leaf blast, incidence and grain yield at Maiduguri and Gashua agroecological locations in 2007 croppign season.

	Heading (days)	**Plant height (cm)**	**Panicle length (cm)**	**Leaf blast incidence (%)**	**Grain yield (kg/ha)**
Means	57.5	38.0	5.9	40.2	831.0
Range	56 – 59.5	25.2 – 53.5	4.2 – 7.5	5.6 – 90.5	176 – 1812
CV (%)	3.00	7.65	11.26	8.57	20.67

DISCUSSIONS

Leaf blast (*Magnaphorthe grisea*) is a major counterproduction biotic factor wherever foxtail millet is grown without adequate protection. The results shows that the leaf blast incidence increase with each successive increase in fungicide seed treatment level and increased significantly with each increase in seed rate at Maiduguri and Gashua locations in 2007. The results of this work revealed that an increase in seed rate with a corresponding increase in the plant population resulted to a highly significant decrease in the plant height and panicle length which could be due to competition for light, space and other essential mineral requirements.

The results has obviously shown that the optimum attainable grain yield of foxtail millet is possible within the fungicide seed treatment level ranging from 80 – 100% and seed rate of 10kg/ha. This finding agree with Emechebe *et al.* (1994) which reported that seed dressing with an effective chemical is a viable option for disease control and higher yield production for the peasant farmers in the West African Sudan Savannah. Anaso *et al.* (1989) stated that seed dressing with Apron Plus 35SD controlled downy mildew in maize and also Richard *et al.* (2009) reported that seed dressing with Apron star 42DS (metalaxyl) t the rate of 2.5 product a.i kg/ha lowered the incidence and severity of sorghum anthracnose. In the two agroecological locations, results showed that the disease incidence and the resultant yield loss was higher at Maiduguri than Gashua location. This could probably be due to favourable humid environmental condition which was favourable for spore germination, sporulation and dispersal with a resultant high leaf blast incidence and yield reduction. This results agree with Kato *et al.* (2000), Eto *et al.* (2001) and Farman (2002) which reported that leaf blast affect photosynthetic activity and transport of metabolites in the crop. The findings of this work are also in conformity with Skerman and Riveros (1990) which reported that the leaf blast is among the major three diseases of foxtail millet and that the yield of the crop ranges from 800 – 900kg/ha with flowering data ranging form 56 – 65days.

CONCLUSION

This work has clearly shown that an appropriate Apron star seed dressing fungicide level and appropriate seed rate can lower the incidence of leaf blast, increase plant height, panicle length and reduce yield loss. Therefore, this result will immensely serve as a first-hand vital information to the farmers for the effective management of foxtail millet diseases in Nigerian Savannah and other parts of the semi-arid region.

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